jc685 U.S. PTO

06/06/00

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Sir:

Transmitted herewith for filing under 37 C.F.R. §1.53(b) is the patent application of:

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For: SOLID STATE IMAGE PICKUP DEVICE AND ITS CONTROL METHOD

XX Specification (20 pages)
XX _6_ sheets of drawings
XX Declaration and Power of Attorney
    XX Newly executed
XX Return Receipt Postcard
XX An assignment of the invention to Fuji Photo Film Co., Ltd. with PTO-1595
XX A certified copy of Japan application No. 11-161247 dated June 8, 1999
XX A filing fee, calculated as shown below:

	(Col. 1)	(Col. 2)		Small Entity			Other Than A Small Entity	
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TOTAL CLAIMS	6 - 20 =	* 0		× 9 =		or	× 18 =	
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Respectfully submitted,

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SOLID STATE IMAGE PICKUP DEVICE AND ITS CONTROL METHOD

This application is based on Japanese Patent Application HEI

11-161247, filed on June 8, 1999, the entire contents of which are incorporated herein

5   by reference.

BACKGROUND OF THE INVENTION

a) Field of the Invention

The present invention relates to a solid state image pickup device

10   having photoelectric conversion elements and its control method, and more

particularly to techniques for controlling charge accumulation times of photoelectric

conversion elements.

b) Description of the Related Art

Exposure times (charge accumulation times) of red (R), green (G) and

15   blue (B) pixels of a conventional color solid state image pickup device are controlled

uniformly.   If an image is picked up under external light having a shifted color

temperature, a color balance of the picked-up image becomes poor.   For example, if

a scene having a high color temperature, i.e., a bluish scene, is taken, although a

sufficient signal for B pixels can be obtained, signals for G and R pixels are small.

20   When color image signals having a good white balance are to be obtained from such

signals, the dynamic range of the color image is determined basing upon the color

signal having the smallest amplitude, in this case, R signal.   A reproduced image has

a poor color balance in a bright image area, being insufficient for R color and rather

having a magenta hue.   A reddish scene such as an evening scene has a tendency

25   opposite to that described above.

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SUMMARY OF THE INVENTION

It is an object of the present invention to provide a solid state image pickup device and its control method capable of obtaining an image having a good white balance and an image with good color reproductivity, by controlling the charge accumulation times of photoelectric conversion elements independently for each color.

According to one aspect of the present invention, there is provided a control method for a solid state image pickup device having a plurality type of photoelectric conversion elements for converting light of each of a plurality of colors into electric charges, charge read-out region disposed, a mechanical shutter for opening and closing a path of incident light to the plurality type of photoelectric conversion elements, and an electronic shutter for clearing electric charges in each of the plurality type of photoelectric conversion elements, the control method comprising:

a preliminary trial image pickup step of making the plurality type of photoelectric conversion elements generate and accumulate electric charges during a predetermined charge accumulation time and detecting a charge amount corresponding to an intensity of light of each color; a calculation step of calculating a charge accumulation time of photosensitive conversion elements independently for each color so as to obtain a good white balance, in accordance with the charge amount corresponding to the intensity of light of each color detected by the preliminary trial image pickup step; and a final image pickup step of controlling the charge accumulation time of photosensitive conversion elements independently for each color by using the electronic shutter, the mechanical shutter, and read-out of electric charges from the photoelectric conversion elements to the charge transfer paths read-out region, in accordance with the calculated charge accumulation times, and making the plurality type of photoelectric conversion elements generate and

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accumulate electric charges.

According to another aspect of the present invention, there is provided a solid state image pickup device comprising: a plurality type of photoelectric conversion elements for converting light of each of red, green and blue colors into

5 electric charges, the photoelectric conversion elements being disposed in vertical and horizontal directions in a two-dimensional plane; vertical charge transfer paths for transferring electric charges in the vertical direction; read gates for reading electric charges from the photoelectric conversion elements to the vertical charge transfer paths; a horizontal charge transfer path for transferring electric charges transferred

10 from the vertical charge transfer paths in the horizontal direction; an electronic shutter for clearing electric charges in the plurality type of photoelectric conversion elements; preliminary trial image pickup means for making the plurality type of photoelectric conversion elements generate and accumulate electric charges during a predetermined charge accumulation time and detecting a charge amount

15 corresponding to an intensity of light of each color; calculation mean for calculating a charge accumulation time of photoelectric conversion elements independently for each color so as to obtain a good white balance, in accordance with the charge amount corresponding to the intensity of light of each color detected by the preliminary trial image pickup means; and final image pickup means for

20 controlling the charge accumulation time of photoelectric conversion elements independently for each color by using the electronic shutter, the mechanical shutter, and read-out of electric charges from the photoelectric conversion elements to the vertical charge transfer paths, in accordance with the calculated charge accumulation times, and making the plurality type of photoelectric conversion elements generate

25 and accumulate electric charges.

At the first preliminary trial image pickup stage, the charge accumulation

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time of photoelectric conversion elements for each color is determined so as to obtain a good white balance. In accordance with each charge accumulation time, the charge accumulation times of the photoelectric conversion elements for respective colors are determined to perform a final image pickup operation.

5   At the first image pickup stage, the charge accumulation time of photoelectric conversion elements for each color is determined so as to obtain a good white balance. In accordance with each charge accumulation time, the charge accumulation times of the photoelectric conversion elements for respective colors are determined to perform a final image pickup operation. Accordingly, color image

10   signals having a good color reproductivity can be obtained. Since the mechanical shutter and an electronic shutter are used, an image having a wide dynamic range can be obtained.

BRIEF DESCRIPTION OF THE DRAWINGS

15   Fig. 1 is a timing chart illustrating an operation of a solid state image pickup device according to an embodiment of the invention.

Fig. 2 is a graph showing a photodiode output relative to a charge accumulation time of each color pixel.

Fig. 3 is a timing chart illustrating an operation of a solid state image

20   pickup device according to another embodiment of the invention.

Fig. 4 is a cross sectional view of a semiconductor substrate having a drain for draining electric charges from a vertical charge transfer path to the external.

Fig. 5A is a plan view of a solid state image pickup device, and Fig. 5B is a schematic cross sectional view of an electronic still camera.

25   Fig. 6 is a plan view showing an example of transfer electrodes for reading charges independently for odd and even columns.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 5A is a plan view of a color solid state image pickup device according to an embodiment of the invention. The solid image pickup device is

5 formed on a semiconductor substrate 1 made of silicon or the like. The semiconductor substrate 1 has a plurality of photodiodes (photoelectric conversion elements) 2, vertical charge transfer paths (VCCD) 3, transfer gates (read gates) 4, a horizontal charge transfer path (HCCD) 6, an output amplifier 7, drains 10, and a control unit 8, respectively formed on the surface of the semiconductor substrate 1 as

10 one semiconductor chip. The control unit 8 may be formed on a different chip.

The photodiodes are disposed in a two-dimensional matrix shape. Each photodiode converts received light into electric charge and stores the charge. Color filters are disposed on a light reception area of the photodiodes. R represents a photodiode (pixel) with a red filter, G represents a pixel with a green filter, and B

15 represents a pixel with a blue filter. The layout of color pixels shown in Fig. 5A is called a primary color Bayer matrix. In order to make it easy to understand, only 24 pixels are drawn in Fig. 5A. The embodiment is not limited only to 24 pixels, and an actual solid state image pickup device has pixels far more than 24 pixels.

As a mechanical shutter MS disposed above the substrate 1 is opened,

20 external light is incident upon all photodiodes 2. As the mechanical shutter MS is closed, the photodiodes 2 are shielded from the external light. The exposure time (charge accumulation time) of each photodiode 2 starts when the mechanical shutter MS is opened, and ends when it is closed.

Fig. 5B is a schematic cross sectional view of an electronic still camera.

25 A lens L mounted on the front of the camera receives external light which forms an image on a semiconductor chip 1 or CCD image pickup device via a mechanical

shutter MS.   The mechanical shutter MS is controlled by a shutter button SB.

The control unit 8 can drain electric charges in each photodiode 2 to the substrate (collector region) 1 by applying an electronic shutter signal to the substrate. The exposure time of each photodiode 2 can start also by using the electronic shutter

5   signal.

Each vertical charge transfer path 3 is formed on the left side of each column of photodiodes 2 via transfer gates 4.   The transfer gate 4 reads electric charges in the corresponding photodiode 2 to the vertical charge transfer path 3. Electric charges can be read independently for each of three colors RGB.   For

10   example, transfer gates 4 can be controlled independently for odd and even columns of each row.

Fig. 6 shows an example of transfer gates capable of reading electric charges independently for odd and even columns.   Photodiodes 2 disposed in a matrix shape and vertical charge transfer paths 3 formed adjacent to each photodiode

15   column are similar to those shown in Fig. 5A.

Electrodes P2A and P1A sandwich one row of photodiodes and constitute adjacent transfer stages on the vertical charge transfer path 3.   Electrodes P2B and P1B operate in a manner similar to the electrodes P2A and P1A.   The electrodes P1A and P1B are made of a first polysilicon layer, and the electrodes P2A

20   and P2B are made of a second polysilicon layer.

Each electrode has long transfer electrodes TE1 and short transfer electrodes TE2 alternately disposed along the row direction on the respective vertical charge transfer paths 3.   Along each vertical charge transfer path, two long transfer electrodes and two short transfer electrodes are alternately disposed, like

25   TE1-TE1-TE2-TE2-TE1-TE1.

As a read voltage is applied to the electrode P2A, accumulated charges

are read from G pixels on every second column to corresponding vertical charge transfer paths.   Similarly, as a read voltage is applied to the electrode P1A, P2B, or P1B, accumulated charges are read from every second column R, G or B pixels.   In summary, the relation between the electrodes and read pixels is given by:

5   P2A, P2B: G

         P1A   : R

         P1B   : B

         As a read voltage is applied to the electrode P2A or P2B, one set of G electric charges per four transfer electrodes is read to corresponding vertical charge

10   transfer paths 3.   As a read voltage is applied to the electrode P1A or P1B, one set of R or B electric charges per four transfer electrodes is read to corresponding vertical charge transfer paths 3.   Read electric charges are transferred in vertical direction in the respective vertical charge transfer paths by applying four-phase drive signals V1, V2, V3 and V4 to the electrodes P2A, P1A, P2B and P1B.

15   The vertical charge transfer paths 3 are made of charge coupled devices (CCDs) and transfer electric charges read from the photodiodes 2 from the upper area of the drawing of Fig. 5A to the lower area (in a vertical direction).   The horizontal charge transfer path 6 is made of a CCD, receives electric charges of one row unit transferred from the vertical charge transfer paths 3 and transfers the

20   charges from the left area of the drawing of Fig. 5A to the right area (in a horizontal direction).

         An output amplifier 7 outputs a voltage corresponding to the amount of electric charges transferred from the horizontal charge transfer path 6.   This voltage value corresponds to a pixel value.   Each photodiode 2 corresponds to a pixel.   By

25   disposing the photodiodes two-dimensionally, signals of a two-dimensional image can be obtained.

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The control unit 8 controls the transfer gates 4 to read electric charges from photodiodes 2 to the vertical charge transfer paths 3, controls the vertical charge transfer paths 3 and horizontal charge transfer path 6, and/or controls to clear electric charges in each photodiode 2.

5   Unnecessary electric charges on each vertical charge transfer path 3 can be transferred from the lower area to the upper area and drained to a drain 10 formed at the upper end of the vertical charge transfer path 3.

As a user half-depresses the shutter button SB, the solid state image pickup device performs a tentative image pickup.   The output amplifier 7 outputs

10   RGB signals obtained by the tentative image pickup.   By using the RGB signals, a calculation unit 9 performs calculations of white balance, automatic exposure and the like.   In accordance with the calculation results, exposure times are determined. More specifically, the exposure time is determined independently for each of R, G and B pixels.   As the user full-depresses the shutter button SB, a final image pickup is

15   performed by using the determined exposure times.   The details of the tentative and final image pickup operations will be described.

Fig. 1 is a timing chart illustrating the image pickup operation of a solid state image pickup device according to an embodiment of the invention.

As a preliminary trial image pickup (tentative image pickup) stage, the

20   mechanical shutter 11 is opened.   Thereafter, an electronic shutter pulse is supplied at time t_1 to clear electric charges in all photodiodes 2.   This electronic shutter pulse supplied at time t_1 initializes all the photodiodes 2 and starts the exposure time (charge accumulation time).   At time t_2, a charge read pulse is applied to the transfer gates 4 corresponding to the photodiodes (pixels) 2 of all colors to read electric

25   charges in the RGB photodiodes 2 to the vertical charge transfer paths 3.   Each vertical charge transfer path 3 transfers the electric charges downward in the vertical

direction.   The horizontal charge transfer path 6 receives the electric charges from the vertical charge transfer paths and transfers the electric charges right in the horizontal direction.   The output amplifier 7 outputs RGB signals obtained by the tentative image pickup.

5   Next, as a calculation stage, by using the RGB signals obtained by the tentative image pickup, the calculation unit 9 calculates the charge accumulation time independently for each of RGB pixels in order to obtain a good white balance of an image to be reproduced.   This calculation method will be described with reference to Fig. 2.

10   In Fig. 2, the abscissa represents a charge accumulation time (exposure time) and the ordinate represents a photodiode output (accumulated charge amount) corresponding to the intensity of light received by a photodiode.   The tentative image pickup is performed at an exposure time of $T_{SO}(t_2 - t_1)$, and light intensities I_{RO}, I_{GO} and I_{BO} of RGB colors can be obtained by adding electric charges accumulated in the

15   photodiodes of each color.

Optimum charge accumulation times Tr, Tg and Tb of RGB colors can be calculated from the following equations:

$$Tr = T_{SO} \times (I_{SO}/I_{RO}) \times k$$

$$Tg = T_{SO} \times (I_{SO}/I_{GO}) \times k$$

20          $$Tb = T_{SO} \times (I_{SO}/I_{BO}) \times k$$

where Tr, Tg and Tb represent optimum charge accumulation times of red, green and blue pixels, I_{SO} represents a saturated light intensity, and I_{RO}, I_{GO} and I_{BO} represent detected light intensities (accumulated charges) of red, green and blue colors, and k represents an adequate gain.

25   Next, the final image pickup is performed.   At time t_3, an electronic shutter pulse is applied to the substrate 1 to clear electric charges of all the

photodiodes 2. This electronic shutter pulse starts a first exposure time of photodiodes.

If the calculation results are Tr < Tg < Tb, at time t_4 after a lapse of about Tb - Tg, a B signal read pulse is supplied to the transfer gates 4 of the blue pixels. Conversely, if the calculation results are Tr > Tg > Tb, at time t_4 after a lapse of about Tr - Tg, an R signal read pulse is supplied to the transfer gates 4 of the red pixels. The former case corresponds to the timing chart shown in Fig. 1. At time t_4, B signals are read to the vertical charge transfer paths 3. This read operation terminates the first exposure time Tb1 for B photodiodes. The first exposure time Tb1 is a time duration from time t_3 to time t_4.

After the B signal is read, an electronic shutter pulse is supplied at time t_5 to reset or drain electric charges in all the photodiodes to the substrate 1. This reset starts a second exposure time Tb2 of B pixels, an exposure time Tg for G pixels and an exposure time Tr for R pixels.

After the lapse of the exposure time Tr from time t_5, an R pixel read pulse is supplied to read R signals from the R photodiodes 2 to the vertical charge transfer paths 3. This read operation terminates the exposure time Tr.

Next, at time t_6 after the lapse of the exposure time Tg (=Tb2) after the reset timing t_5, the mechanical shutter is closed to shield light incident upon the photodiodes 2. At time t_6, the exposure times Tg and Tb2 are terminated. The exposure times Tg and Tb2 are the time durations from time t_5 to time t_6.

The exposure time Tb for B pixels is a total of the first exposure time Tb1 and the second exposure time Tb2. The exposure time for G pixels is Tg and the exposure time for R pixels is Tr.

At time t_6, the electric charges during the second exposure time Tb2 for B pixels remain in the photodiodes and the electric charges during the first exposure

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time Tb1 for B pixels remain in the vertical charge transfer paths 3. The electric charges during the exposure time Tg for G pixels remain in the photodiodes 2. The electric charges during the exposure time Tr for R pixels remain in the vertical charge transfer paths 2.

5 Next, a B pixel read pulse is supplied to read B signals from the photodiodes 2 to the vertical charge transfer paths 3. This read operation adds (mixes) the electric charges already stored in the vertical charge transfer paths 3 during the first exposure time Tb1 to (with) the electric charges read to the vertical charge transfer paths 3 during the second exposure time Tb2. The electric charges 10 for R pixels during the exposure time Tr have already been read to the vertical charge transfer paths 3.

Next, R and B electric charges (signals) on the vertical charge transfer paths 3 are transferred downward in the vertical direction in Fig. 5A. The horizontal charge transfer path 6 transfers the R and B signals received from the vertical charge 15 transfer paths 3 in the horizontal direction. The output amplifier 7 outputs the electric charges as voltage signals to the external.

Next, at time t_7, a G pixel read pulse is supplied to read G signals from the photodiodes to the vertical charge transfer paths 3. Thereafter, the G signals on the vertical charge transfer paths 3 are transferred downward in the vertical direction 20 in Fig. 5A. The horizontal charge transfer path 6 transfers the G signals received from the vertical charge transfer paths 3 in the horizontal direction. The output amplifier 7 outputs the G electric charges as voltage signals to the external.

With the processes described above, the exposure times Tr, Tg and Tb for R, G and B signals can be controlled independently, and RGB pixel signals having 25 a good white balance can be obtained.

Next, an image pickup operation of a solid state image pickup device

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according to another embodiment of the invention will be described with reference to the timing chart shown in Fig. 3.

As the preliminary trial image pickup (tentative image pickup) stage, the mechanical shutter is opened. Thereafter, an electronic shutter pulse is supplied at time t_1 to reset all photodiodes 2. This reset starts accumulating the electric charges in the photodiodes of all pixels. At time t_2, a charge read pulse is generated to read electric charges of RGB pixels from the photodiodes 2 to the vertical charge transfer paths 3.

Next, as the calculation stage, by using the electric charges of RGB pixels obtained by the preliminary trial image pickup stage, the charge accumulation time is calculated for each group of RGB pixels in order to obtain a good white balance of an image to be reproduced. The above processes are same as the first embodiment.

Next, the final image pickup stage is performed. It is assumed that the calculation results are Tr < Tg < Tb. First, at time t_3 an electronic shutter pulse is supplied to reset all photodiodes 2. This reset starts an exposure time for B pixels.

Next, after a lapse of Tb - Tg from the time t_3, a G signal read pulse is supplied to read unnecessary G signals from the G pixel photodiodes 2 to the vertical charge transfer paths 3. This read operation resets the G pixel photodiodes 2 and starts an exposure time Tg. The unnecessary G pixel electric charges read to the vertical charge transfer paths 3 are transferred upward in the vertical direction shown in Fig. 5A and drained to the drains 10.

After a lapse of Tb - Tr from time t_3, an R signal read pulse is supplied to read unnecessary R signals from the R pixel photodiodes 2 to the vertical charge transfer paths 3. This read operation resets the R pixel photodiodes 2 and starts an exposure time Tr. The unnecessary R pixel electric charges read to the vertical

charge transfer paths 3 are transferred upward in the vertical direction shown in Fig. 5A and drained to the drains 10.

Next, at time t_4 after the lapse of an exposure time Tb after time t_3, the mechanical shutter is closed. At time t_4, the exposure times Tb, Tg and Tr are terminated. After all the unnecessary G and R signals on the vertical charge transfer paths 3 are drained to the drains 10, B and R pixel read signals are supplied to read B and R signals from the photodiodes 2 to the vertical charge transfer paths 3.

The vertical charge transfer paths 3 transfer the B and R signals downward in the vertical direction shown in Fig. 5A. The horizontal charge transfer path 6 transfers the B and R signals in the horizontal direction, and the output amplifier 7 outputs voltage signals corresponding to the B and R signals to the external.

Next, a G pixel read pulse is supplied to read G signals from the photodiodes 2 to the vertical charge transfer paths 3. The vertical charge transfer paths 3 transfer the G signals downward in the vertical direction shown in Fig. 5A. The horizontal charge transfer path 6 transfers the G signals in the horizontal direction, and the output amplifier 7 outputs voltage signals corresponding to the G signals to the external.

With the processes described above, the exposure times Tr, Tg and Tb for R, G and B signals can be controlled independently, and RGB pixel signals having a good white balance can be obtained.

In the first and second embodiments, it is assumed that the calculation results are Tb > Tg > Tr. The embodiments are also applicable to the calculation results of Tb < Tg < Tr. In this case, the control operations for B and R pixels are reversed.

Fig. 4 is a cross sectional view taken along line IV-IV shown in Fig. 5A

and showing the drain 10.   In a p-type semiconductor region 21 in an n-type Si

substrate 20, an n-type semiconductor region (vertical charge transfer path) 3 and an

n^+-type semiconductor region (drain) 10 are formed.   A positive potential Vdr is

applied to the n^+-type semiconductor region 10.   A conductive film (polysilicon film)

5   23 is formed on an insulating film 22 above the n-type semiconductor region 3.   A

gate voltage Vg is applied to the conductive film 23.   As a positive potential is applied

as the gate voltage Vg, electric charges on the vertical charge transfer path 3 are

transferred and then drained to the drain 10 at the positive potential Vdr.

A p^+-type electrode region 25 is formed in the surface layer of the p-type

10   region 21, and connected to a ground terminal GND.   An n^+-type electrode region 27

is formed in the surface layer of the n-type substrate 20, and connected to an

overflow drain/electronic shutter terminal OFD.   By applying a selected high voltage

to the terminal OFD, the potential barrier formed by the p-type region 21 under the

photodiode 2 (Fig. 1) can be extinguished and electric charges in the photodiode 2

15   can be drained to the substrate 20.

The present invention has been described in connection with the

preferred embodiments.   The invention is not limited only to the above embodiments.

It will be for those skilled in the art apparent that various modifications,

improvements, combinations, and the like can be made.

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WHAT IS CLAIMED IS:

1.   A control method for a solid state image pickup device having a plurality type of photoelectric conversion elements for converting light of each of a plurality of colors into electric charges, charge read-out region disposed adjacent to each of the

5   photoelectric conversion elements, a mechanical shutter for opening and closing a path of incident light to the plurality type of photoelectric conversion elements, and an electronic shutter for clearing electric charges in each of the plurality type of photoelectric conversion elements, the control method comprising:

a preliminary trial image pickup step of making the plurality type of

10   photoelectric conversion elements generate and accumulate electric charges during a predetermined charge accumulation time and detecting a charge amount corresponding to an intensity of light of each color;

a calculation step of calculating a charge accumulation time of photosensitive conversion elements independently for each color so as to obtain a

15   good white balance, in accordance with the charge amount corresponding to the intensity of light of each color detected by said preliminary trial image pickup step; and

a final image pickup step of controlling the charge accumulation time of photosensitive conversion elements independently for each color by using the

20   electronic shutter, the mechanical shutter and read-out of electric charges from the photoelectric conversion elements to the charge transfer paths read-out region, in accordance with the calculated charge accumulation times, and making the plurality type of photoelectric conversion elements generate and accumulate electric charges.

25   2.   A control method for a solid state image pickup device according to claim 1, wherein the solid state image pickup device further comprises charge transfer paths

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including said charge read-out region for transferring electric charges in the photoelectric conversion elements, the plurality type of photoelectric conversion elements are capable of converting light of at least first to third colors into electric charges, and said final image pickup step comprises the steps of:

5 (a) starting a first charge accumulation time for the first color by the electronic shutter;

(b) reading electric charges from the photoelectric conversion elements of the first color to the charge transfer paths to terminate the first charge accumulation time of the first color;

10 (c) starting a second charge accumulation time for the first color, a charge accumulation time for the second color and a charge accumulation time for the third color by the electronic shutter;

(d) reading electric charges from the photoelectric conversion elements of the third color to the charge transfer paths to terminate the charge accumulation 15 time for the third color; and

(e) closing the mechanical shutter to terminate the charge accumulation time for the first color and the charge accumulation time for the second color.

3. A control method for a solid state image pickup device according to claim 2, 20 further comprising the steps of:

(f) reading electric charges from the photoelectric conversion elements of the first color to the charge transfer paths;

(g) transferring the electric charges for the first and third colors on the charge transfer paths;

25 (h) reading electric charges from the photoelectric conversion elements of the second color to the charge transfer paths; and

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(i) transferring the electric charges for the second color on the charge

transfer paths.

4. A control method for a solid state image pickup device according to claim 1,

5 wherein the solid state image pickup device further comprises charge transfer paths

including said charge read-out region for transferring electric charges in the

photoelectric conversion elements, the plurality type of photoelectric conversion

elements are capable of converting light of at least first to third colors into electric

charges, and said final image pickup step comprises the steps of:

10   (a) starting a first charge accumulation time for the first color by the

electronic shutter;

          (b) reading unnecessary electric charges from the photoelectric

conversion elements of the second color to the charge transfer paths to terminate a

charge accumulation time of the second color;

15   (c) reading unnecessary electric charges from the photoelectric

conversion elements of the third color to the charge transfer paths to terminate a

charge accumulation time of the third color; and

          (d) closing the mechanical shutter to terminate the first, second and

third charge accumulation times.

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5. A control method for a solid state image pickup device according to claim 4,

further comprising the steps of:

          (e) draining the unnecessary charges for the second and third colors

read to the charge transfer paths;

25   (f) reading electric charges from the photoelectric conversion elements

of the first and third colors to the charge transfer paths;

(g) transferring the electric charges for the first and third colors on the charge transfer paths;

(h) reading electric charges from the photoelectric conversion elements of the second color to the charge transfer paths; and

5   (i) transferring the electric charges for the second color on the charge transfer paths.

6.   A solid state image pickup device comprising:

a plurality type of photoelectric conversion elements for converting light

10   of each of red, green and blue colors into electric charges, the photoelectric conversion elements being disposed in vertical and horizontal directions in a two-dimensional plane;

vertical charge transfer paths for transferring electric charges in the vertical direction;

15   read gates for reading electric charges from the photoelectric conversion elements to the vertical charge transfer paths;

a horizontal charge transfer path for transferring electric charges transferred from said vertical charge transfer paths in the horizontal direction;

an electronic shutter for clearing electric charges in the plurality type of

20   photoelectric conversion elements;

preliminary trial image pickup means for making the plurality type of photoelectric conversion elements generate and accumulate electric charges during a predetermined charge accumulation time and detecting a charge amount corresponding to an intensity of light of each color;

25   calculation mean for calculating a charge accumulation time of photoelectric conversion elements independently for each color so as to obtain a

good white balance, in accordance with the charge amount corresponding to the

intensity of light of each color detected by said preliminary trial image pickup means;

and

final image pickup means for controlling the charge accumulation time

5   of photoelectric conversion elements independently for each color by using said

electronic shutter, said mechanical shutter, and read-out of electric charges from the

photoelectric conversion elements to said vertical charge transfer paths, in

accordance with the calculated charge accumulation times, and making the plurality

type of photoelectric conversion elements generate and accumulate electric charges.

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ABSTRACT OF THE DISCLOSURE

A control method for a solid state image pickup device has: a preliminary trial image pickup step of making a plurality type of photoelectric conversion elements generate and accumulate electric charges during a

5   predetermined charge accumulation time and detecting a charge amount corresponding to an intensity of light of each color; a calculation step of calculating a charge accumulation time of photosensitive conversion elements independently for each color so as to obtain a good white balance, in accordance with the charge amount corresponding to the intensity of light of each color detected by the

10   preliminary trial image pickup step; and a final image pickup step of controlling the charge accumulation time of photosensitive conversion elements independently for each color by using the electronic shutters and a mechanical shutter and through reading electric charges from the photoelectric conversion elements to vertical charge transfer paths, in accordance with the calculated charge accumulation times, and

15   making the plurality type of photoelectric conversion elements generate and accumulate electric charges. An image having a good white balance and an image with good color reproductivity can be obtained by controlling the charge accumulation times of photoelectric conversion elements independently for each color.

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FIG.1

**MECHANICAL SHUTTER** — OPEN | CLOSE

ELECTRONIC SHUTTER

READ B CHARGES

B SIGNAL ACCUMU-LATION TIME

T_{b2}

T_{b1}

READ B SIGNAL

READ G CHARGES

G SIGNAL ACCUMU-LATION TIME T_g

READ G SIGNAL

READ R CHARGES

R SIGNAL ACCUMU-LATION TIME T_r

READ R SIGNAL

TRANSFER SIGNALS TO EXTERNAL

READ IMAGE SIGNALS FOR CALCULATION OF CONTROL SIGNALS

TRANSFER R,B SIGNAL

TRANSFER G SIGNAL

t_1 t_2 t_3 t_4 t_5 t_6 t_7

⟶ TIME

FIG.2

FIG.3

MECHANICAL SHUTTER

OPEN | CLOSE

ELECTRONIC SHUTTER

READ B CHARGES

READ B SIGNAL

READ G CHARGES

READ G SIGNAL

READ R CHARGES

READ R SIGNAL

TRANSFER SIGNALS TO EXTERNAL

B SIGNAL ACCUMULATION TIME T_b

G SIGNAL ACCUMULATION TIME T_g

R SIGNAL ACCUMULATION TIME T_r

READ R SIGNAL

READ IMAGE SIGNALS FOR CALCULATION OF CONTROL SIGNALS

DRAIN SIGNALS ON V TRANSFER PATH TO EXTERNAL

TRANSFER R,B SIGNAL

TRANSFER G SIGNAL

t_1 t_2 t_3 t_4

$\longrightarrow$ TIME
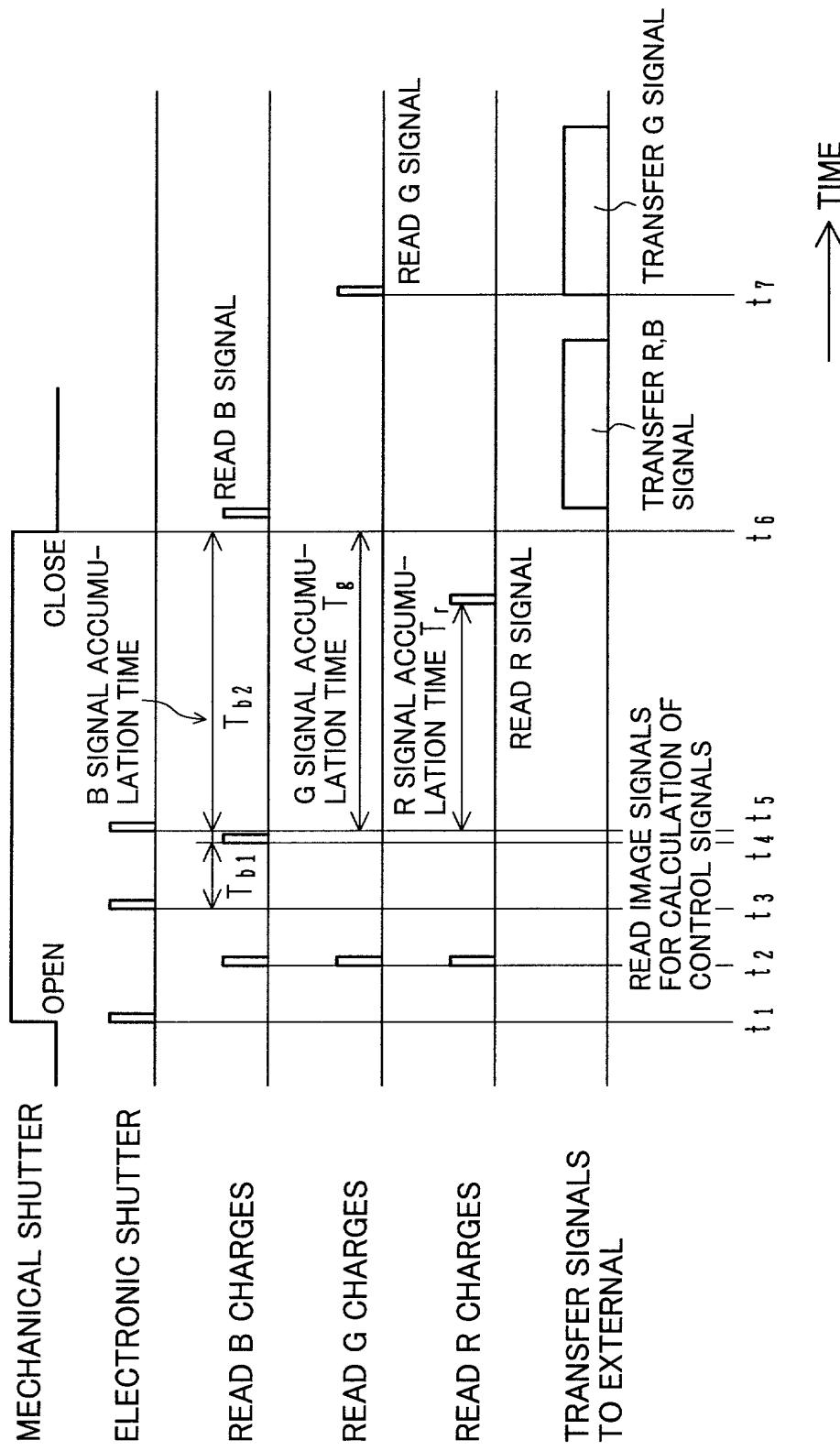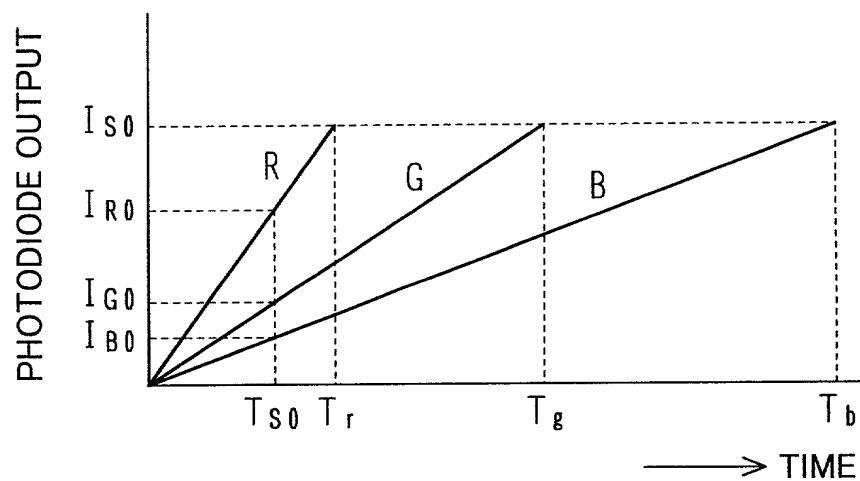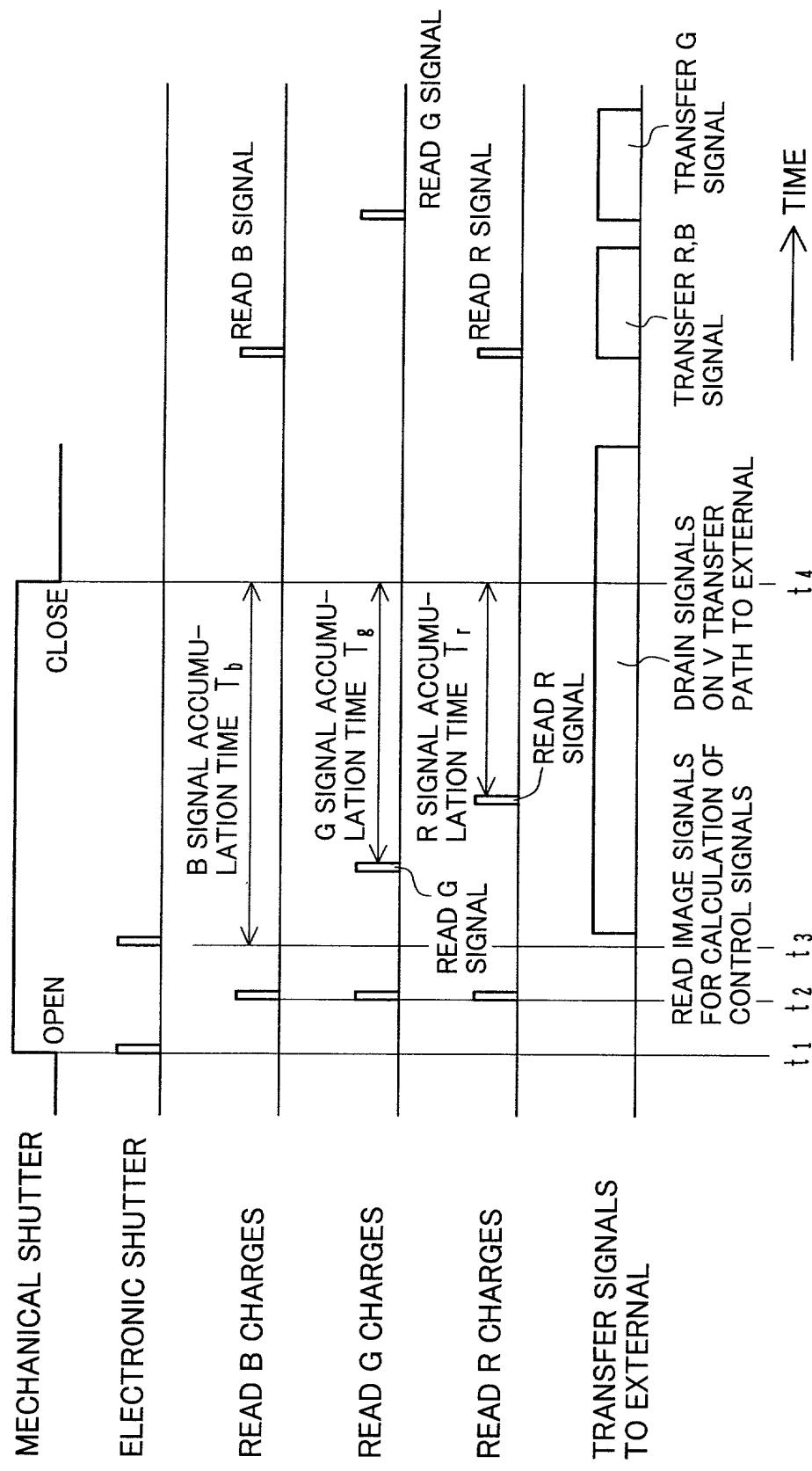
FIG.4
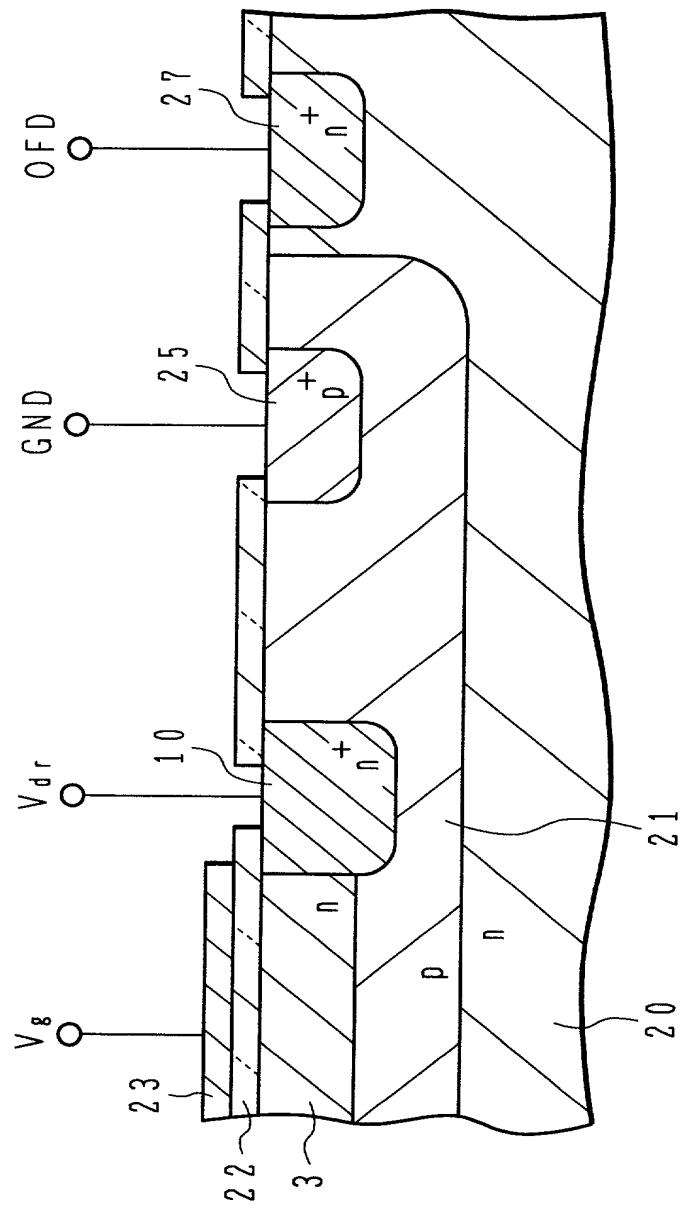
FIG.5A
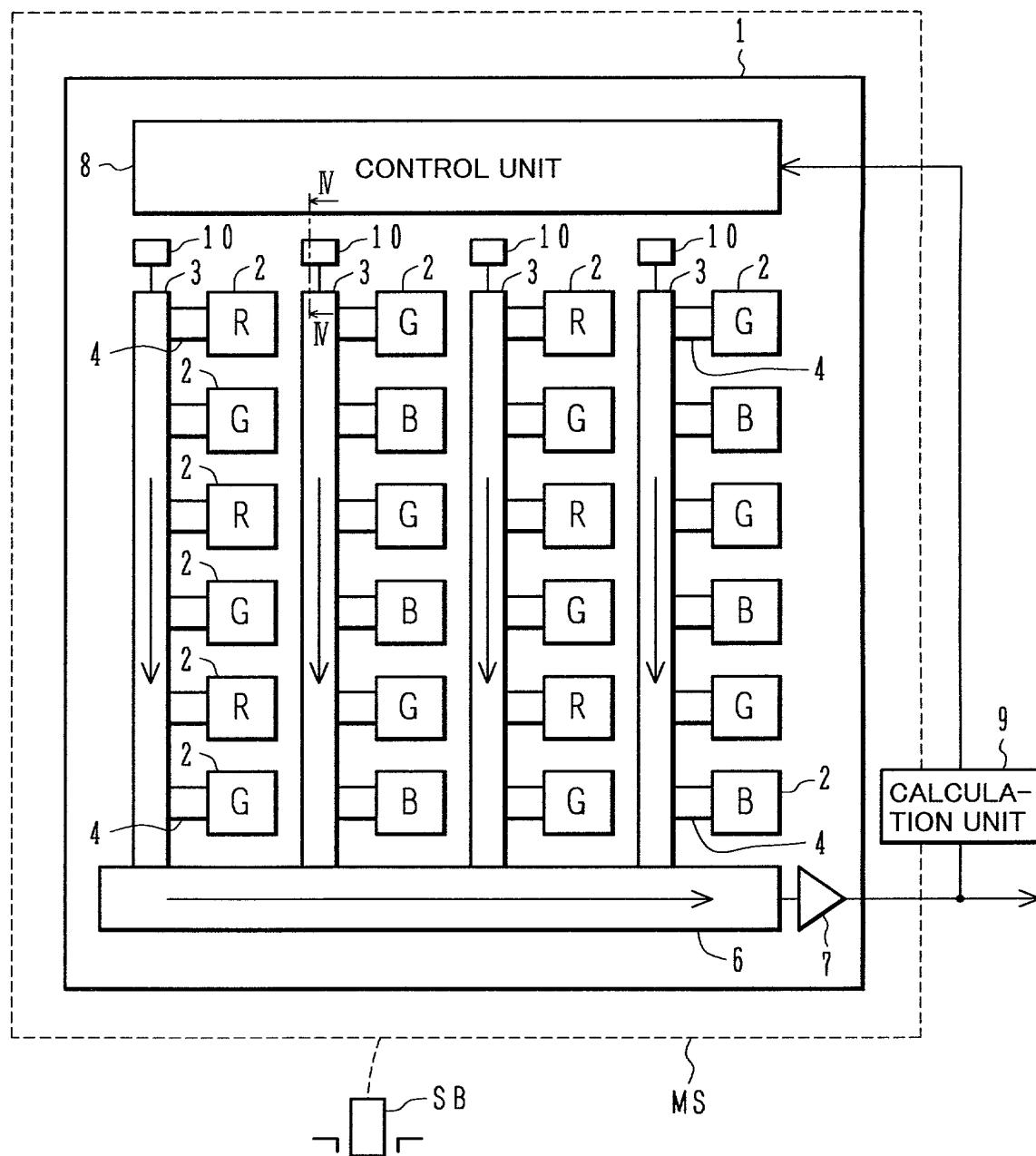
FIG.5B
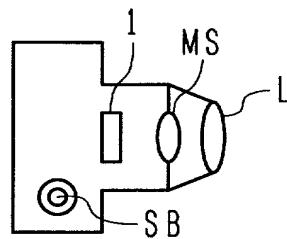
FIG.6
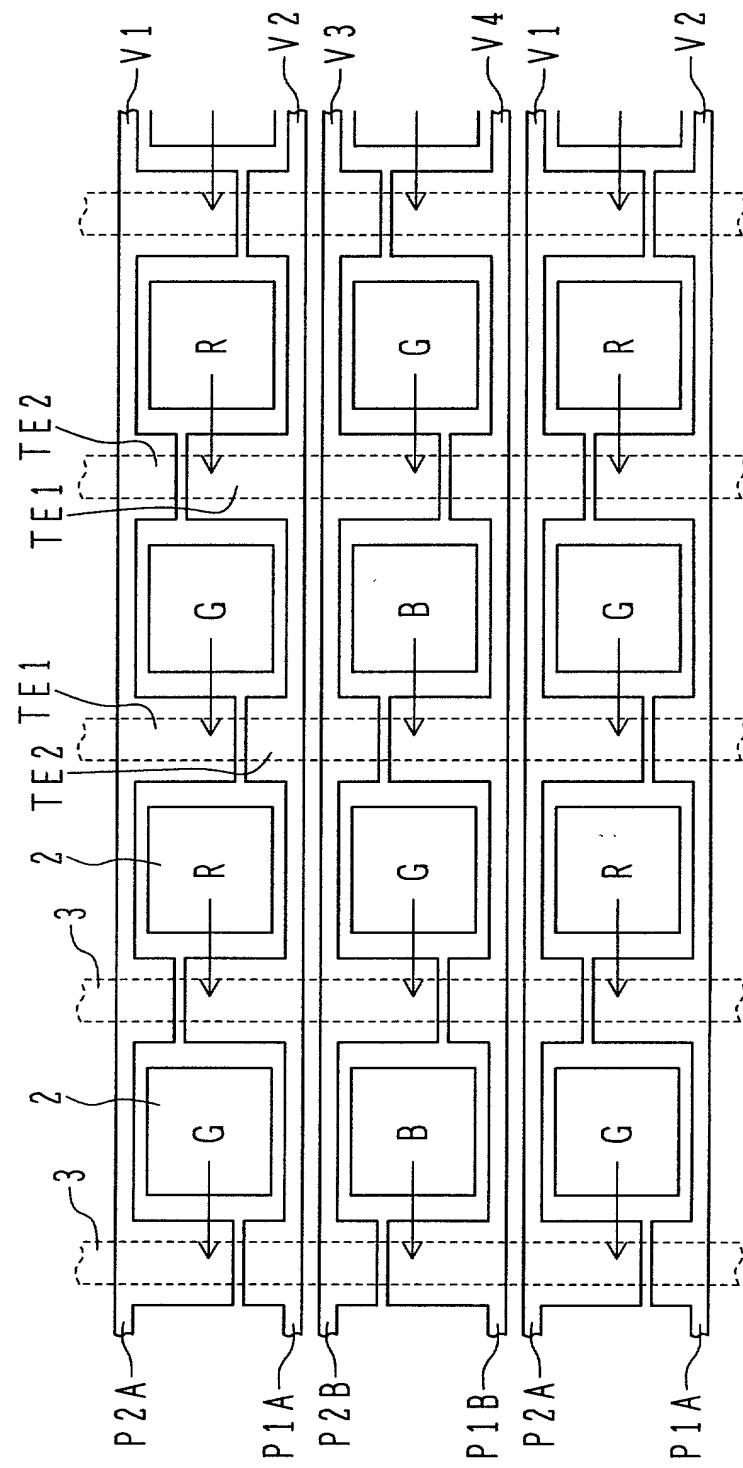
Declaration and Power of Attorney For Patent Application

特許出願宣言書及び委任状

Japanese Language Declaration

日本語宣言書

下記の氏名が発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

私の住所、私書箱、国籍は下記の私の氏名の後に記載された通りです。

My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者であると（下記の名称が複数の場合）信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

_____

_____

<u>SOLID STATE IMAGE PICKUP</u>

<u>DEVICE AND ITS CONTROL</u>

METHOD

上記発明の明細書（下記の欄で×印がついていない場合は、本書に添付）は、

the specification of which is attached hereto unless the following box is checked:

☐ ＿月＿日に提出され、米国出願番号または特許協定条約国際出願番号を＿＿＿＿＿とし、（該当する場合）＿＿＿＿＿に訂正されました。

☐ was filed on ＿＿＿＿＿＿＿＿＿
as United States Application Number or
PCT International Application Number
＿＿＿＿＿＿＿ and was amended on
＿＿＿＿＿＿＿ (if applicable).

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第37編第1条56項に定義されるとおり、特許資格の有無について重要な情報を開示する義務があることを認めます。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

Japanese Language Declaration
（日本語宣言書）

私は、次国法典第３５編１１９条(a)-(d)項又は３６５条 (b)項に基き下記の、米国以外の国の少なくとも一ヶ国を指定している特許協力条約３６５(a)項に基ずく国際出願、又は外国での特許出願もしくは発明者証の出願についての外国優先権をここに主張するとともに、優先権を主張している、本出願の前に出願された特許または発明者証の外国出願を以下に、優内をマークすることで、示しています。

I hereby claim foreign priority under Title 35, United States Code, Section 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)
外国での先行出願

Priority Not Claimed
優先権主張なし

Hei11-161247 (Number) （番号）	Japan (Country) （国名）	08/06/99 (Day/Month/Year Filed) （出願年月日）	二
(Number) （番号）	(Country) （国名）	(Day/Month/Year Filed) （出願年月日）	二

☐ 私は、第３５編米国法典１１９条(e)項に基いて下記の米国特許出願規定に記載された権利をここに主張いたします。

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

(Application No.) （出願番号）	(Filing Date) （出願日）

☐ 私は、下記の米国法典第３５編１２０条に基いて下記の米国特許出願に記載された権利、又は米国を指定している特許協力条約３６５条(c)に基ずく権利をここに主張します。また本出願の各請求範囲の内容が米国法典第３５編１１２条第１項又は特許協力条約で規定された方法で先行する米国特許出願に開示されていない限り、その先行米国出願書提出日実際で本出願書の日本国内または特許協力条約国際提出日までの期間中に入手された、連邦規則法典第３７編１条５６項で定義された特許資格の有無に関する重要な情報について開示義務があることを認識しています。

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of application.

(Application No.) （出願番号）	(Filing Date) （出願日）	(Status: Patented, Pending, Abandoned) （現況： 特許許可済、係属中、放棄済）
(Application No.) （出願番号）	(Filing Date) （出願日）	(Status: Patented, Pending, Abandoned) （現況： 特許許可済、係属中、放棄済）

私は、私自身の知識に基ずいて本宣言書中で私が行なう表明が真実であり、かつ私の入手した情報と私の信じるところに基ずく表明が全て真実であると信じていること、さらに故意になされた虚偽の表明及びそれと同等の行為は米国法典第１８編第１００１条に基ずき、罰金または拘禁、もしくはその両方により処罰されること、そしてそのような故意による虚偽の声明を行なえば、出願した、又は既に許可された特許の有効性が失われることを認識し、よってここに上記のごとく宣言を致します。

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Japanese Language Declaration
(日本語宣誓書)
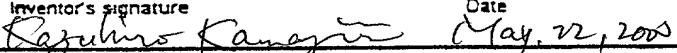
委任状： 私は下記の発明者として．本出願に関する一切の手続きを米国特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。（弁護士．または代理人の氏名及び登録番号を明記のこと）	**POWER OF ATTORNEY:** As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith *(list name and registration number)*
書類送付先	And I hereby appoint as principal attorneys: David T. Nikaido, Reg. No. 22,663; Charles M. Marmelstein, Reg. No. 25,895; George E. Oram, Jr., Reg. No. 27,931; Robert B. Murray, Reg. No. 22,980; E. Marcie Emas, Reg. No. 32,131; Douglas H. Goldhush, Reg. No. 33,125; Monica Chin Kitts, Reg. No. 36,105; Richard J. Berman, Reg. No. 39,107; King L. Wong, Reg. No. 37,500; Karen K. Costantino, Reg. No. 35,107; James A. Poulos, III, Reg. No. 31,714; Patrick D. Muir, Reg. No. 37,403; Sharon N. Klesner, Reg. No. 36,335; and Murat Ozgu, Reg. No. 44,275; Bradley D. Goldizen, Reg. No. 43,637; and N. Alexander Nolte, Reg. No. 45,689.
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発明者の署名　　　　　日付	Inventor's signature　　Date May, 22, 2000
住所	Residence Kurokawa-gun, Miyagi, Japan
国籍	Citizenship Japanese
私書箱	Post Office Address c/o FUJI FILM MICRODEVICES CO., LTD. 1-6, Matsuzakadaira, Taiwa-cho, kurokawa-gun, Miyagi, Japan
第二共同発明者名	Full name of second joint inventor, if any
第二共同発明者の署名　　日付	Second inventor's signature　　Date
住所	Residence
国籍	Citizenship
私書箱	Post Office Address
（第三以降の共同発明者についても同様に記載し、署名をすること）	(Supply similar information and signature for third and subsequent joint inventors.)